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THE

AVOIDANCE

OF

COLLISIONS AT SEA.

BY

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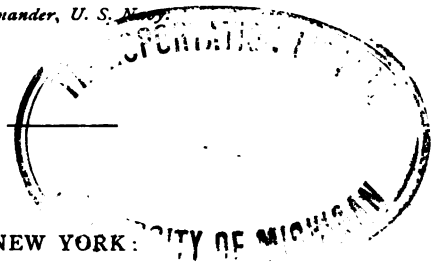

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PREFACE.

IN placing this tract upon the avoidance of collisions in book form before the public, one is naturally led to inquire whether there is sufficient novelty in the treatment of a subject, about which so much has been written, as to warrant its publication.

I think that there is, all owing to the good work performed by Captain Colomb, R.N., in giving us critical diagrams of the manœuvring powers of steam vessels to work by.

From a consideration of these diagrams I have endeavored to draw certain conclusions which will enable simple directions

to be laid down, so that one steam vessel can avoid collision with another, even when the latter vessel may so act as to court such a disaster. In regard to avoiding collision with a sailing vessel on the part of a steamer, the problem should be of still easier solution, since you have to deal with generally less speed, and you have always the direction of the wind for a point of reference. In cases where one sailing vessel must avoid another, the wind permits its actions to be those of a steamer manœuvring under the same circumstances.

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WASHINGTON, D. C.,
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COLLISIONS.

I.

CAPTAIN COLOMB, R.N., in his late work entitled "The Dangers of the Modern 'Rule of the Road' at Sea, and the Manœuvring Powers of Ships as affecting Collision" (Griffin & Company, Portsmouth, England, 1885), gives diagrams which represent the manœuvring powers of steam vessels of different sizes moving at different speeds. The performances of these vessels may be said to represent so many types, since they are drawn from a consideration of over three thousand curves; therefore I think that we are entitled to deduce from them certain conclusions in regard to avoiding collisions which will apply to all steam vessels on the seas.

Among the conclusions reached are the following:

1. Altering course is not the same as altering the ship's head. If a vessel was steering north, and its helm was put hard over until it headed N. E. by E. ½ E., it will really have steered somewhere about N. by E., and it will have taken it something like four times its length to do this in.

2. If the speed is changed, and the helm is put over at the same instant, the vessel will turn through the first octant (that is, the first four points) on *nearly* the same curve that it would if no change had been made in the speed. For instance, if a vessel at full speed was to back suddenly and put its helm over at the same time, the vessel would turn on *nearly* its full-speed curve in *nearly* the same time. However, if the engines were reversed, the speed of the ship (if a single screw), after she had changed the direction of her head four points,

would be *nil*, and the greatest effect would be exercised on checking her advance.

3. To avoid collision, when the separating distance is very small, each vessel *must* manœuvre to avoid collision.

4. Ships in turning, when the helm is put over, instead of starting out immediately to pass to the right or left of the course in obedience thereto, move first bodily to that side towards which the helm is first put, and *then* turn in the proper direction, but are not clear of their former courses until their heads have changed direction *fully* three points, two or more ship's lengths ahead of the point at which their helms were put over.

5. After a ship's head has turned through five or six points the chances of collision are not increased or lessened by the rest of the turn. The time required to do this with a vessel moving at the rate of twelve knots is about eighty-five seconds. The

vessel's advance in this case would be about six times her length, and her transfer would be about twice her length.

This diagram (Fig. 1) represents the positions, taken five seconds apart, assumed by a ship of nine thousand tons moving at the rate of twelve knots on the straight, and with a helm angle of thirty-four degrees when hard over. If the vessel went at less speed her curve, with the same amount of helm, would be substantially the same, as we have before said. If she had nine knots speed her *advance*, after the turn begins, would be about seventy-five per cent. of that shown in the figure, her *transfer* eighty per cent. If she had a speed of six knots her advance would be about fifty per cent. of that shown in the figure, and her transfer sixty per cent.*

* The *advance* is the distance covered to the front in the direction of the original course; the *transfer* is the distance normal to this line, measured to the right or left.

Here are three diagrams (Fig. 2) which show comparatively the areas occupied by vessels of the same size moving on a straight at the rates of twelve, nine, and six knots. It will be observed that no matter what the vessels may do with their helms or engines, during eighty-five seconds each ship will be somewhere within the line bounding the figure representing her manœuvring power. This may be termed her *manœuvring area.*

It follows, then, that if this space surrounding a vessel is avoided, during the time indicated, by another vessel, no collision can occur, no matter how stupidly the vessel to be avoided may manœuvre.

Now, if the manœuvring area was moved along the line of the vessel's course, it would be bounded by the two parallel lines *c*, *c'*, *d*, *d'* (see Fig. 3). The included space may be termed the "track."

When the tracks of two ships, A and B, intersect, the figure included, *e*, *f*, *g*, *h*, will

represent the space in which collision will occur; furthermore, it is the *only* space in which collision can occur, both vessels being, under these circumstances, within this area at the same time. Therefore, if the ship to manœuvre does not have her manœuvring area completely overlaid by the track of the vessel to be avoided, *she has only to steer over its free part to make a collision impossible.* Should the track of one vessel entirely overlay the track of another, which can only happen when a vessel bears head on to another which is steering the same or an opposite course, or the manœuvring areas overlay, which can only happen when the vessels are very close together, then the only way to avoid the *collision space* is for both vessels to steer away from it, *each* vessel with its helm the same way.

II.

We will consider the subject under five categories, as follows:

1. Where the manœuvring vessel has much greater speed.
2. Where the manœuvring vessel has an excess of speed.
3. Where the speeds of the two vessels are alike.
4. Where the manœuvring vessel has inferior speed.
5. Where the manœuvring vessel has much less speed than the other vessel.

Under the Rule of the Road the vessel having the other on its starboard side is to manœuvre; the other is to keep its course. Let us consider, first, a case common to all categories (Fig. 4), where two vessels are meeting end on. Here we see that the tracks are one and the same, and therefore, to carry the manœuvring area of one ship

as far as possible from the manœuvring area of the other, each vessel must put its helm so as to turn its track away from the track of the approaching ship. Either helm will do it. The rule is to use port helm.

III.

Let us consider that A in the diagram (Fig. 5) has a speed of twelve knots, and B a speed of six knots, and that B is at B, two points on A's bow, steering the most dangerous course, B*c*, then *c* is the point where the two vessels will collide.

Now, we see that A's manœuvring area is overlaid, except that portion which admits of the use of port helm. Therefore port helm, and port helm alone, in this case can

insure by its employment immunity from collision.

If B was steering a course more towards *d*, her track would infringe more on A's manœuvring area; still port helm for A would be indicated to let her go astern of B, slowing or reversing the engines so as to make as little advance as possible. Where port helm is used, unless the direction in which B is standing is plainly seen—and this could hardly be the case at night—stopping your way by the use of your engines is what is *demanded* in order that you may cut into B's track as little as possible. The nearer the vessels are together the more reason exists for A to reduce speed.

If B was at B_1 (see Fig. 6) on a bearing four points on A's bow, and was steering the most dangerous course, B_1c, the use of port helm would be again indicated, unless A was entirely sure that his speed was twice that of B, in which case the danger of col-

lision is past, since the distance A*c* could be more quickly traversed by A than the distance B_1c could be traversed by B.

IV.

We will now take up the case where A has twelve knots speed and B nine knots speed. We will consider B to be two points on A's starboard bow, steering the course B*c*, which will bring about a collision at *c*. The diagram (Fig. 7) shows the conditions of this relation. It will be seen that if A turns to starboard with port helm a collision will be avoided.

Let us now consider B to bear four points on A's bow at B_1 (Fig. 8), and to be steering the most dangerous course, B_1c. Colli-

sion will occur at *c*, which can, however, be avoided by the use of *either* helm. Port helm would be preferable, from the fact that A would go astern of B by using it. However, by the employment of starboard helm A does not approach B's track at all, but at night we would not know whether B was standing as shown or more in a direction towards *d*, thus sweeping her track down upon A's manœuvring area; port helm would unquestionably be the safest to use, minding your speed at the same time.

When B is so situated as to bear two points forward of A's beam, and is steering any course towards *c*, the danger of collision has ceased, since the distance A*c* is shorter in time than the distance B*c* (see Fig. 9), and A must pass ahead of B.

V.

The next category is where the two vessels, A and B, have each the same speed (Fig. 10). If B is at B, two points on A's bow, and standing on the most dangerous course, B*c*, the vessels will collide at the point *c*. Now the only free portion of A's manœuvring area indicates the use of port helm on her part to avoid infringing on B's track.

If B was at B_1, four points on A's bow, and was steering a course B_1c, then the collision would take place at *c* (see Fig. 11). Here *either* helm *can* be used. Employing starboard helm and going completely around would prevent any likelihood of a collision. although the use of port helm, slowing of course, will put A in a position of safety astern of B in the shortest time, and would be best the nearer B's track was swept towards *d*.

Considering the case where B is two points forward of A's beam at B_2 (Fig. 12), and is steering the dangerous converging course B_2c, it will be seen that the collision will occur at c, and that the use of starboard helm, going around if necessary, will remove A fastest from the collision space.

When B is abeam of A at B_3 (Fig. 13) the danger of collision is past, since any course B might steer could not interfere with A's course, Ac.

VI.

We now come to look into the category where the manœuvring vessel, A, has less speed than the vessel which is to keep its

way. We will suppose that A has a speed of nine knots, while B has the advantage of making three more knots, or can steam at the rate of twelve knots on the straight.

Let us suppose that B is situated two points on A's bow, at B, and is steering the most dangerous course, B*c* (see Fig. 14). As in all other cases where this bearing is considered, the use of port helm is demanded, since the employment of starboard helm infringes more upon B's track. The same may be said of the use of port helm, as we see by the diagram (Fig. 15), if B was at B_1, four points on A's bow, steering the course B_1c. But if B was at B_2 (Fig. 16), two points forward of A's beam, steering the most dangerous course, B_2c, it would require the use of starboard helm on the part of A to keep out of the collision space and to avoid fouling B at *c*. If B bore abeam of A (Fig. 17) and was steering the most dangerous

course, B_3c, it will be seen that A, in order to avoid a collision at the point c, would have to use starboard helm.

VII.

The fifth and last category is where the manœuvring ship has much less speed than the vessel to be avoided. Let us consider that A's speed on the straight is only six knots, while B has, under the same conditions, a speed of twelve knots.

If B bore two points on A's bow and was steering a course Bc, then the collision would take place at c. From the diagram (Fig. 18) we see that port helm must be employed by A to keep out of the collision space.

This is also the case when B is at B_1, four

points on A's bow, as is shown in Fig. 19, where B is steering a course B_1c, since the use of starboard helm makes a greater infringement on B's track; whereas, by the inspection of Fig. 20, where B bears two points forward of A's beam at B_2, the use of starboard helm on the part of A is indicated. The employment of starboard helm by A is also shown in the diagram (Fig. 21), where B is located abeam of A at B_3, and steering a dangerous and converging course B_3c.

VIII.

We have now considered the five categories, and from them we can construct the following table, and deduce several conclusions in regard to avoiding collisions at sea, which we shall proceed to do in order:

TABLE SHOWING WHAT A MUST DO WITH ITS HELM TO AVOID B.

B bears from A—	IF A HAS IN REGARD TO B				
	Much greater speed (A 12 k., and B 6 k.)	An excess of speed (A 12 k., and B 9 k.)	Equal speed (A 12 k., and B 12 k.)	Inferior speed (A 9 k., and B 12 k.)	Much less speed (A 6 k., and B 12 k.)
Ahead.	Both port.	Both port.	Both port.	Both port.	Both port.
Two points on the bow.	Port.	Port.	Port.	Port.	Port.
Four points on the bow.	Danger ceases.	Either helm, (*best slow and port.*)	Either helm, (*best slow and port.*)	Port.	Port.
Two points forw'rd beam.		Danger ceases.	Starboard.	Starboard.	Starboard.
Abeam.			Danger ceases.	Starboard.	Starboard.

What is here indicated is not always the very best as regards conserving the shortest distance to a destination, but where the above directions are followed the danger of collision is very much lessened and the manœuvring vessel will be most apt to avoid the other, no matter what action the latter vessel may take as regards her speed or helm. Of course vessels may approach so closely, through unforeseen circumstances, that these directions may, perhaps, not apply; but if vessels can see one another but a very few minutes before they would collide, providing the circumstances surrounding their helm and speed are as indicated, there is hardly any reason why they should foul one another.

From what has been gone over I think that we can logically deduce the following conclusions where only one vessel is called upon to manœuvre:

1. The area from ahead of the manœu-

vring vessel to four points on its starboard bow can be called the *port helm octant*, in which port helm will be used; and the area from four points on a vessel's starboard bow to a bearing on its starboard beam can be called the *starboard helm octant*, in which starboard helm will be used.

2. Whenever, to avoid collision, starboard helm is used, the manœuvring vessel can by backing, stopping, or reducing speed, according to the proximity of the ships, put the vessel to be avoided in the port helm octant.

3. The greater the difference of speed between the vessels, provided the faster vessel is the manœuvrer, the smaller the sector of danger as regards bearings, and the shorter the time in which a collision can take place; and the converse to this when the slower vessel manœuvres. For example, where A has a speed of twelve knots and B a speed of only six knots, danger of collision

ceases at four points on the bow; whereas if A has a speed of only six knots and B has a speed of twelve knots, danger would only cease when B bore abaft A's beam. The time required to avoid a collision in the first case would be less than two minutes, in the second an indeterminately long time.

4. It is always right to turn as short at you can, and with as little speed.

IX.

In regard to avoiding collision when the vessels have, through accident, come within distances which require manœuvring on the part of each, it will be as well to look first at the difference of the manœuvring areas of the *same ship*, one taken when going

ahead at twelve knots on the straight, and the other when the vessel is backing from a speed of twelve knots on the straight. The helm angle is the same in each instance. Let us look at the diagram (Fig. 22). The continuous lines give the manœuvring area when going ahead; the dotted lines the manœuvring area when the vessel has its engines reversed.

The speed at A is twelve knots, while at A, it has commenced to fall off, and will disappear and turn to sternboard in about fifteen seconds. At B the vessel steaming ahead has a speed of nine knots, while at B′ the backing vessel has no speed. In each case, though, the vessel has about turned through the same number of points, and the time that the ship has taken to arrive at these two positions has been in each instance the same—that is, about seventy-five seconds. You will notice further that the difference in advance between B and B′ is less than

half a ship's length, and that the transfer is still less.

Having said this much, let us put two vessels in a position where there is a *necessity* for each to manœuvre (Fig. 23). B is in the octant of port helm. Nothing which one vessel can do can insure her going clear of the other, since both vessels are, in point of time, only forty-five seconds apart, and each vessel's track overlays the other's; but if B used her helm (Fig. 23) to turn *from* A, and A herself turned to starboard with port helm, the greatest distance would be put between them. If A should at the same time reverse her engines the distance would be still greater.

If B was in the octant of starboard helm (Fig. 24) the same rule would hold good of each ship turning from the other, A using her starboard helm and backing, or else going clear around, and B using her port helm and turning to starboard.

A rule may therefore be laid down that the vessel which under other circumstances would keep her course should, when the separating distance is very small, *turn from the manœuvring ship.* The manœuvring vessel should obey the rule laid down in the table, and at the same time reverse her engines.

Captain Colomb says of vessels nearer than four hundred yards, which distance will, at twelve knots speed, be passed over in twenty seconds by two vessels approaching: "Neither law nor seamanship can undertake impossibilities, and if ships get within a couple of lengths of each other when movement is necessary to avoid collision, we cannot lay down rules for them, because it can only be in some very rare cases that rules can be of any avail."

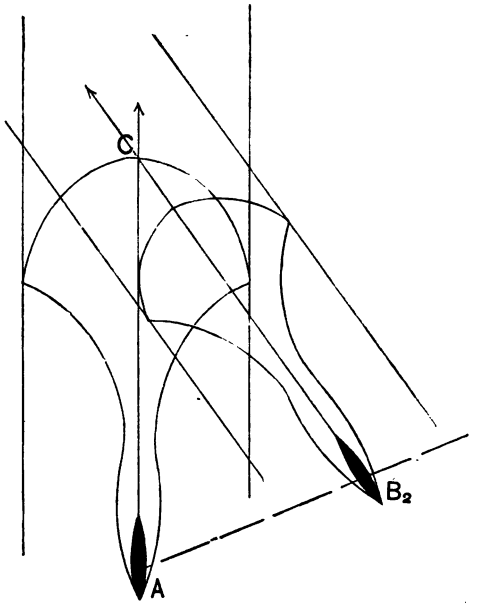
X.

In regard to avoiding collisions with sailing vessels the Rule of the Road orders that all steamers are to keep out of their way. In daytime the conditions of the wind and sea should always permit one's judgment to determine how the sailing vessel is to be avoided, but at night it is always best to try and pass astern by getting the vessel in the bow octant, which can be done unless the vessel is well abeam and near to. In every case where the sailing vessel is on the starboard side, with the red light alone visible, the rule laid down in the table will apply. In every case where the sailing vessel is on the port side, with green light alone to be seen, the rule laid down in the table will apply by substituting the word STARBOARD for PORT, and PORT for STARBOARD. In other words, steamers should

slow, if they are uncertain of the speed and course of the sailing vessel, until the vessel is in the bow octant and then should go astern of the light.

END.

Fig. 9



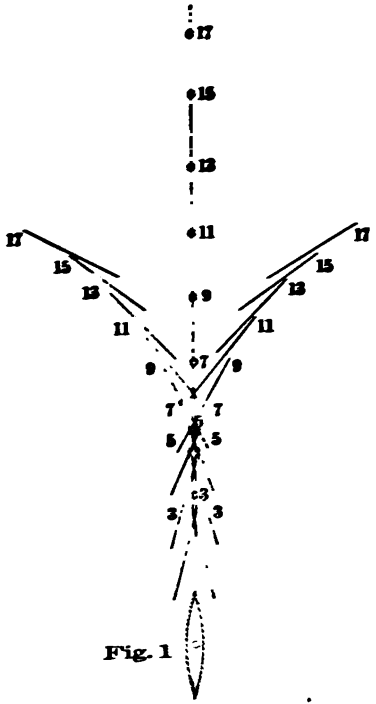


Fig. 1

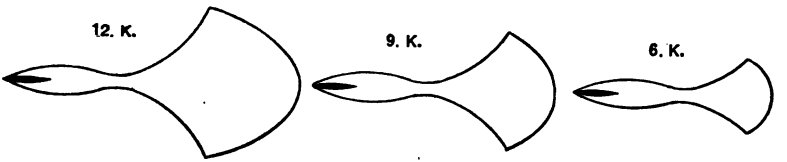


Fig. 2

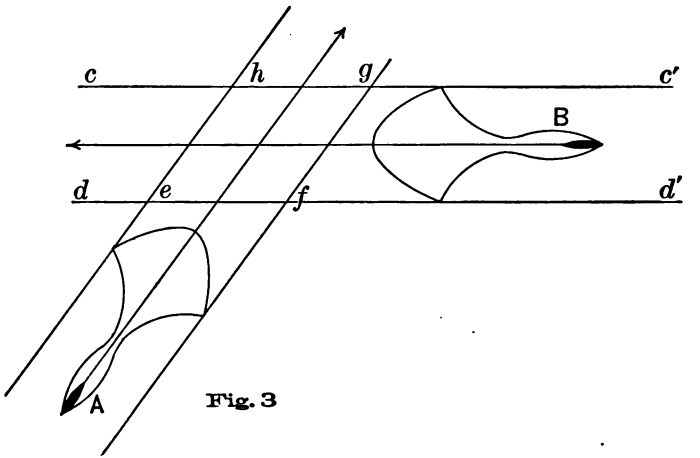


Fig. 3

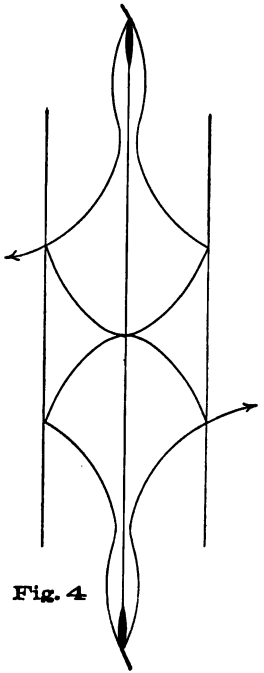


Fig. 4

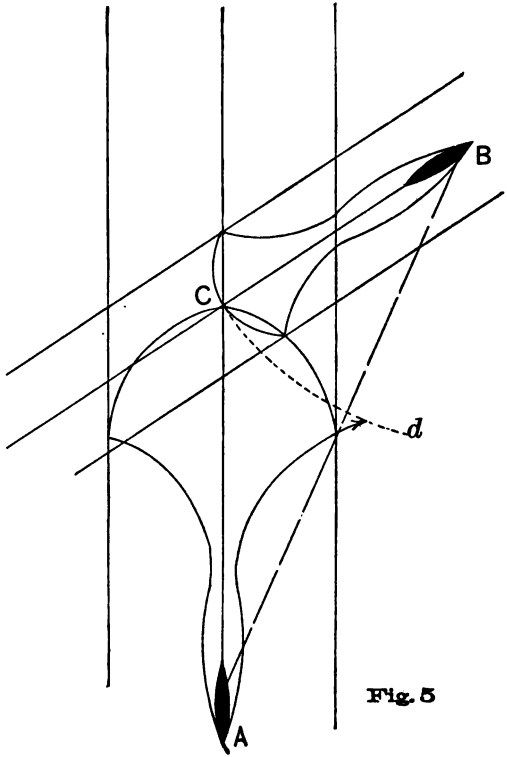


Fig. 5

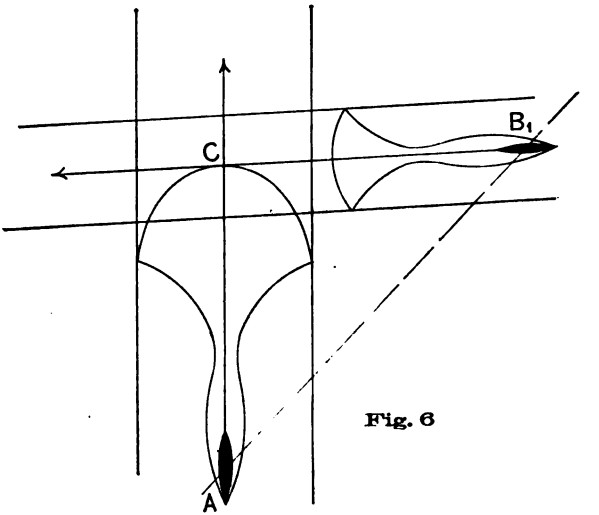
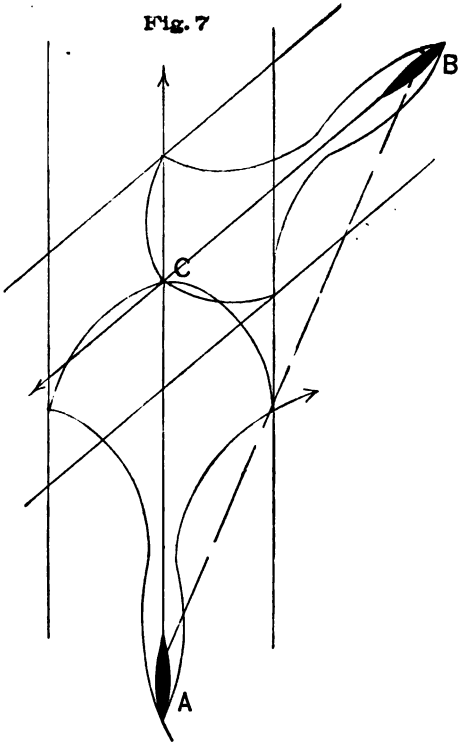


Fig. 6

Fig. 7



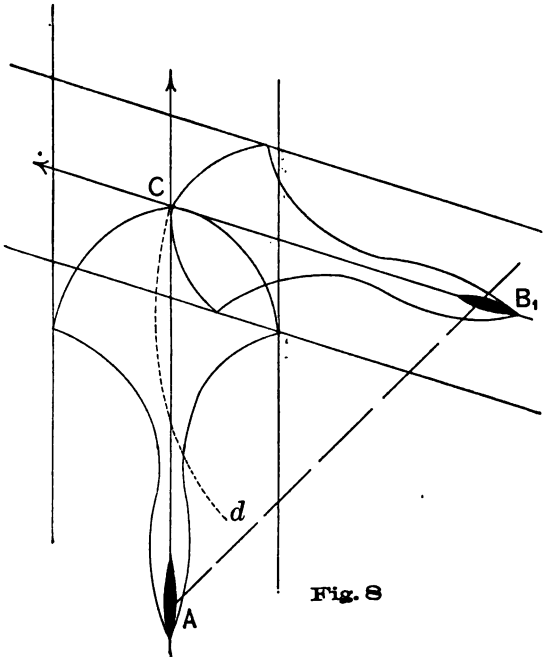


Fig. 8

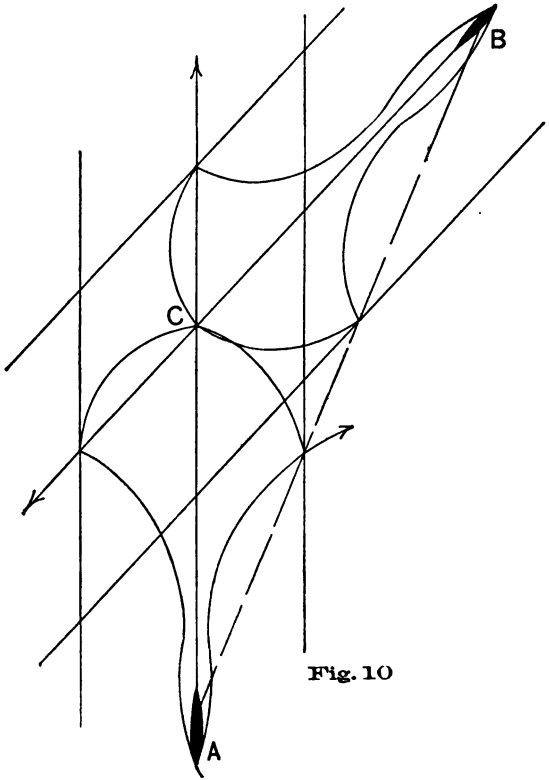


Fig. 10

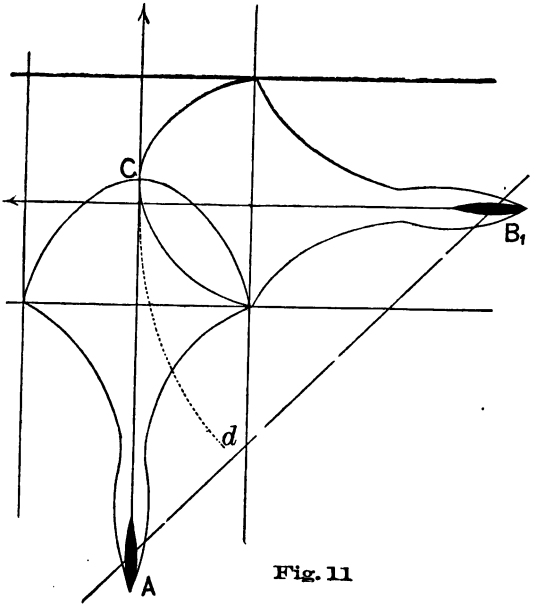


Fig. 11

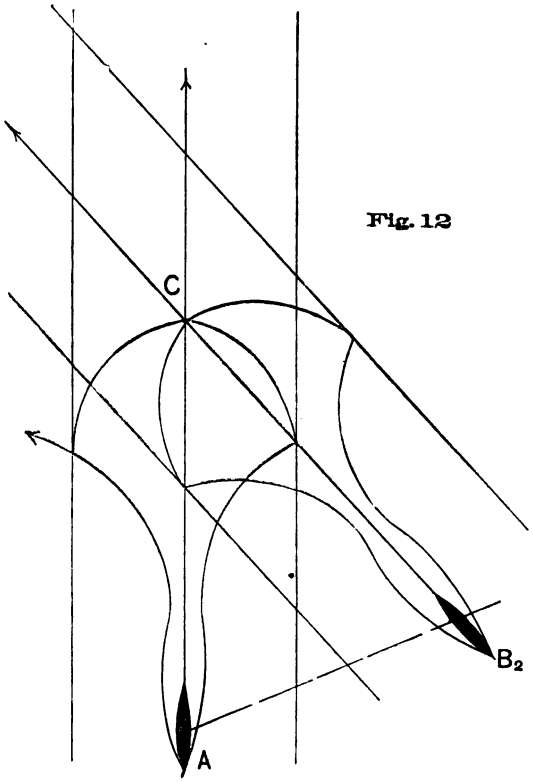


Fig. 12

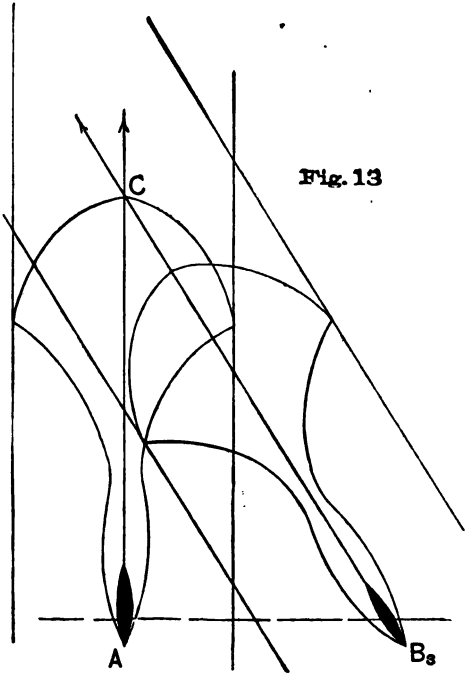


Fig. 13

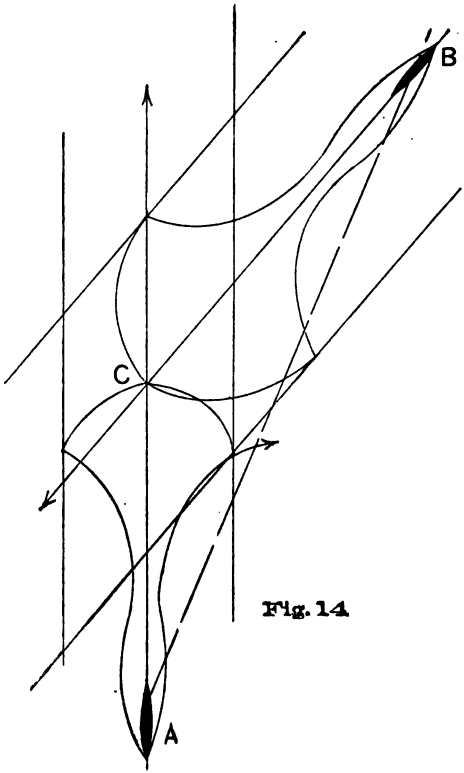


Fig. 14.

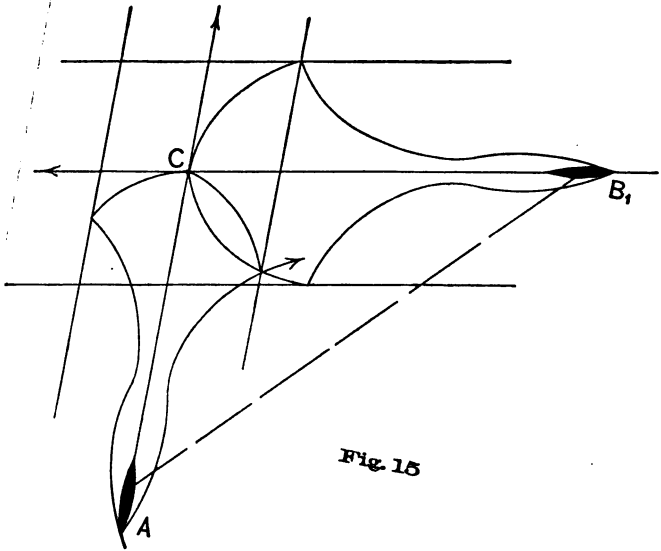


Fig. 15

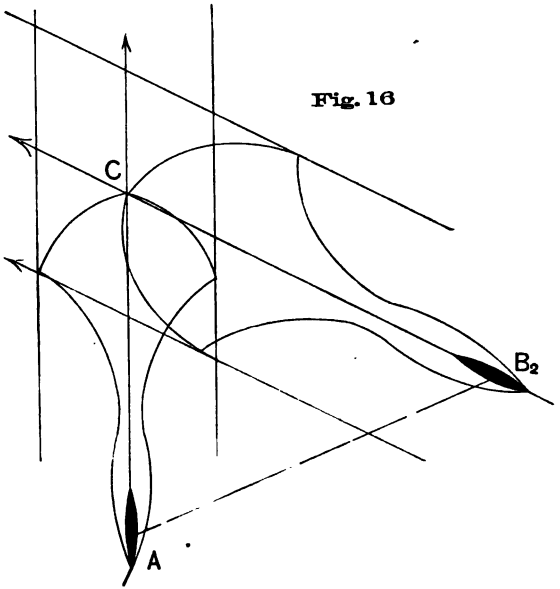


Fig. 16

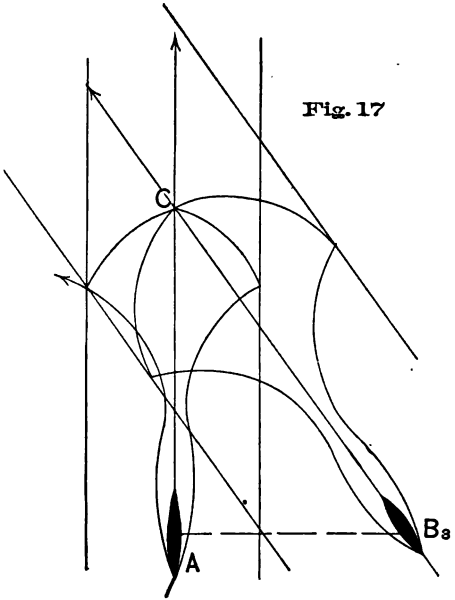


Fig. 17

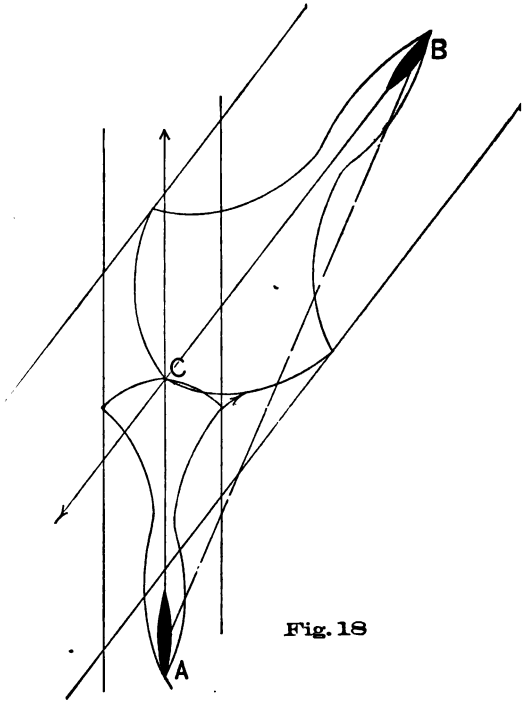


Fig. 18

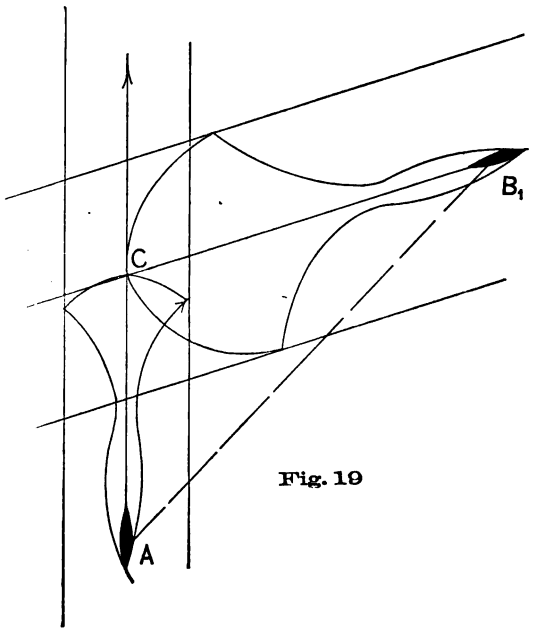


Fig. 19

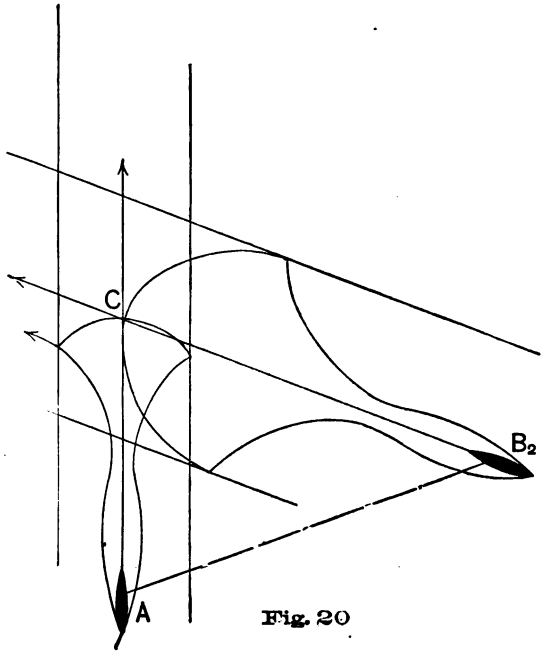


Fig. 20

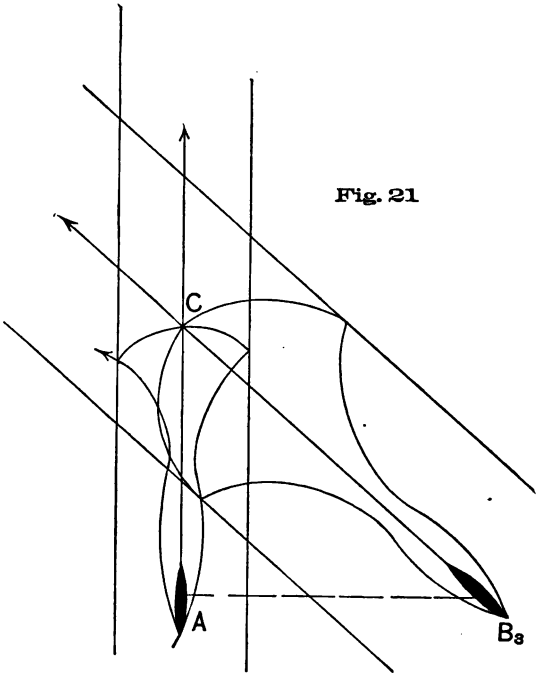


Fig. 21

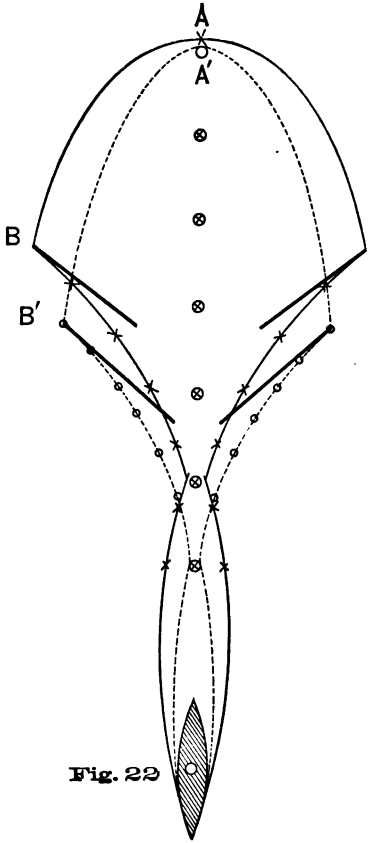


Fig. 22